Small Business Innovation Research/Small Business Tech Transfer

Effects of BLI and Inflow Distortion on Noise Generation and Performance of Fan-Rotor, Phase I

Completed Technology Project (2018 - 2019)

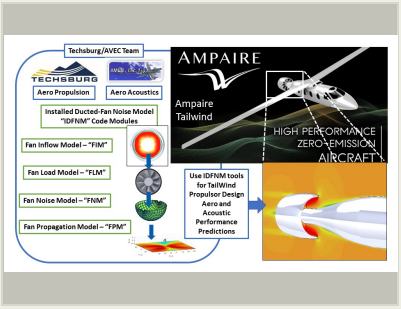
Project Introduction

In response to NASA SBIR topic *A1.02 Quiet Performance – Propulsion Noise Reduction Technology*, the team of Techsburg, AVEC, and Ampaire proposes implementation and design application of a ***low-order noise modeling tool for installed ducted fan-rotor aerodynamic and acoustic analysis***. Named the "Installed Ducted-Fan Noise Model" (IDFNM), and following after Techsburg/AVEC's work in noise modeling for pusher propellers, this tool will offer early-stage design analysis support for installed ducted fan-rotor propulsion systems by capturing the aerodynamic unsteady loading and noise sources resulting from inflow distortion or non-uniform inflow. This tool is well suited for highly integrated and innovative propulsion airframe integration concepts, such as boundary layer ingesting fan configurations. Application of this tool will focus on a highly-efficient design for Ampaire's TailWind electric aircraft. In collaboration with Ampaire, Techsburg and AVEC will work to design an optimized first-generation BLI ducted fan for the TailWind passenger aircraft. During Phase I, Techsburg and AVEC will work on design tool maturation, and also conduct a propulsor design trade study, complete with aerodynamic and acoustic predictions, for the TailWind aft-mounted, boundary layer ingesting ducted fan. Phase II work will include an anechoic wind tunnel test program for validation of prediction tools over a range of operating conditions and the delivery of an integrated low-order noise prediction software package for the "Installed Ducted-Fan Noise Model".

Anticipated Benefits

The ultimate deliverable of the proposed work is the "Installed Ducted-Fan Noise Model" (IDFNM) which will contribute to NASA's Advanced Air Transport Technology Program and related work as it seeks to improve on conventional aircraft performance and noise emissions. Furthermore, this proposal features focused design work on the Ampaire Tailwind, an aircraft with a BLI ducted fan propulsor in the 500-kW class that is aligned well with NASA's development goals and X-57 roadmap.

Noise from non-uniform flow ingestion into rotating fans is a fundamental engineering problem. The application of inflow distortion noise modeling has many uses apart from ducted fan design and development. These applications include HVAC fan systems, cooling fans, turbomachinery, marine propulsion, impeller/blower cage designs, and commercial products that utilize blowers and fans to move air. These will be investigated as potential markets for the technology and design approach.



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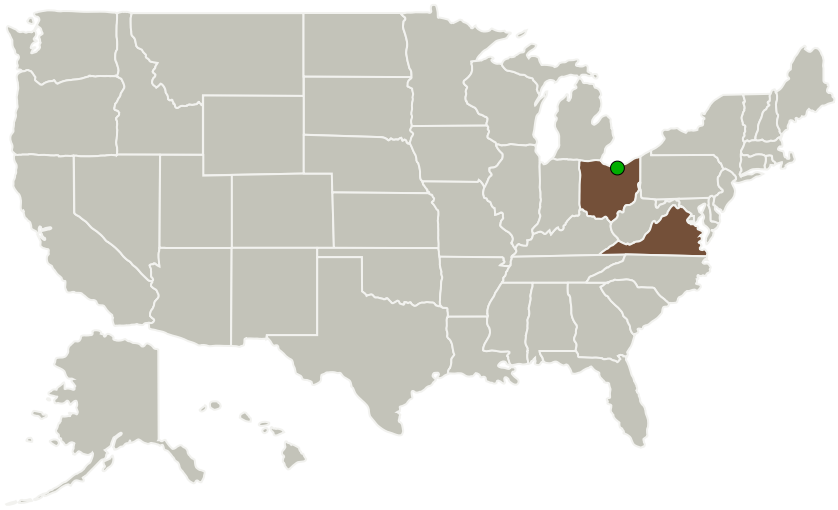
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Technology in Blacksburg, Inc.	Lead Organization	Industry	Christiansburg, Virginia
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
Ohio	Virginia

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141330)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Technology in Blacksburg, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

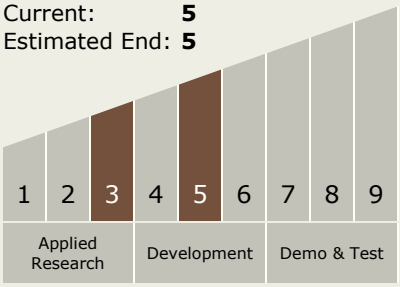
Carlos Torrez

Principal Investigator:

Jonathan Fleming

Technology Maturity (TRL)

Start: **3**
Current: **5**
Estimated End: **5**



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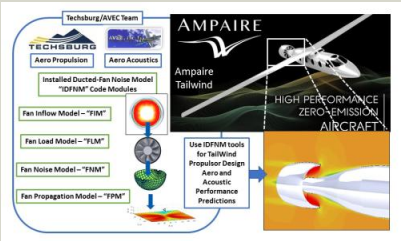
Images



Briefing Chart Image
Effects of BLI and Inflow Distortion on Noise Generation and Performance of Fan-Rotor, Phase I
(https://techport.nasa.gov/image/134292)

Technology Areas

Primary:

- TX15 Flight Vehicle Systems
  - TX15.1 Aerosciences
    - TX15.1.4 Aeroacoustics

Target Destination

Earth